Chapter 4

**Biodiversity and Evolution**

**Core Case Study: Why Are Amphibians Vanishing?**

* Rapid changes in land and water habitats
	+ Most likely caused by \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Amphibians:
	+ Are \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ biological indicators
	+ Play important \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ roles in their communities
	+ Are a genetic storehouse of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ products waiting to be discovered

**4-1 What Is Biodiversity and Why Is It Important?**

* The \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ found in genes, species, ecosystems, and ecosystem processes is vital to sustaining life on the earth

Biodiversity Is a Crucial Part of the Earth’s Natural Capital

* Biodiversity – \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in the earth’s species
* Species – set of individuals who can mate and produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ offspring
	+ \_\_\_\_\_ million to \_\_\_\_\_ million species
	+ About \_\_\_\_\_ million \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ species are mostly in rain forests and oceans
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ diversity
	+ Number and variety of species
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ diversity
	+ Variety of genes in a population
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ diversity
	+ Biomes: regions with distinct climates/species
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ diversity
	+ Variety of processes within ecosystems
* Biodiversity is an important part of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Major Biomes

 \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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**4-2 How Does the Earth’s Life Change Over Time?**

* The scientific theory of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ explains how life on earth changes over time through changes in the genes of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Populations evolve when genes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and give some individuals genetic traits that \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ their abilities to survive and to produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ with these traits (natural selection)

Biological Evolution by Natural Selection Explains How Life Changes over Time

* Fossils
	+ Physical evidence of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ organisms
	+ Reveal what their \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ structures looked like
* Fossil \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – entire body of fossil evidence
* We only have fossils of \_\_\_\_\_ of all species that lived on earth
* Biological evolution – how the earth’s life changes over time through changes in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ characteristics of populations
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – *Origin of Species*
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ selection – individuals with certain traits are more likely to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ under a certain set of environmental conditions
* Huge body of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Mutations and Changes in the Genetic Makeup of Populations

* Populations evolve by becoming \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ different
* Genetic \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ step in biological evolution
	+ Occurs through mutations in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ cells
	+ Mutations – \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ changes in DNA molecules
* Natural selection: acts on \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ step in biological evolution
	+ Adaptation may lead to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ reproduction
	+ Genetic \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – ability of one or more members of a population to resist a chemical designed to kill it

**Case Study: How Did Humans Become Such a Powerful Species?**

* Three adaptations have helped the human species
	+ Strong opposable \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ The ability to walk \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ Complex \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Adaptation through Natural Selection Has Limits

* Adaptive genetic traits must \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ change in the environmental conditions
* A population’s reproductive \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ Species that reproduce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and in large \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ are better able to adapt

Three Common Myths about Evolution through Natural Selection

* Fitness is reproductive \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, not \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Organisms do not develop traits out of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* There is no grand plan of nature for \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ adaptation

**4-3 How Do Geological Processes and Climate Change Affect Evolution?**

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ plate movements, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ eruptions, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ change have shifted wildlife habitats, wiped out large numbers of species, and created opportunities for the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of new species

Geologic Processes Affect \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ Selection

* Tectonic plates affect evolution and the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of life on earth
	+ Locations of continents and oceans have \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ through geologic time
	+ Species \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ move, or adapt, or form new species through natural selection
* Earthquakes – separate and isolate \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Volcanic eruptions – \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ habitats

Climate Change and Catastrophes Affect Natural Selection

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ followed by warming temperatures
* Collisions between the earth and large \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ New species
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**4-4 How Do Speciation, Extinction, and Human Activities Affect Biodiversity?**

* As environmental conditions change, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ between formation of new species and extinction of existing species determines the earth’s \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Human activities can \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ biodiversity:
	+ By causing the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of many species
	+ By \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ habitats needed for the development of new species

How Do New Species Evolve?

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ – one species splits into two or more species
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ isolation
	+ First step
	+ Physical isolation of populations for a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ period
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ isolation
	+ Mutations and natural selection in geographically isolated \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ Leads to inability to produce \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ offspring when members of two different populations mate

All Species Eventually Become Extinct

* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ Process in which an entire species ceases to exist
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ species
	+ Found only in one area
	+ Particularly \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to extinction
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ extinction
	+ Typical \_\_\_\_\_\_\_\_\_\_ rate of extinction
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ extinction
	+ Significant rise above \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ level

**4-5 What Is Species Diversity and Why Is It Important?**

* Species diversity is a major component of biodiversity and tends to increase the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of ecosystems

Species Diversity Includes \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Species \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ Number and variety of species in a given area
* Species \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ The number of different species in a given area
* Species \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ Comparative number of individuals of each species present
* Diversity varies with \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ location
* The most species-rich communities
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Species-Rich Ecosystems Tend to Be \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

* Species richness
	+ Increases \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ or sustainability
	+ Provides insurance against \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* How much species richness do you think is needed?

**4-6 What Roles Do Species Play in an Ecosystem?**

* Each species plays a specific ecological role called its \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Any given species may play one or more of five important roles—\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, or \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_—in a particular ecosystem

Each Species Plays a Role in Its Ecosystem

* Ecological niche
	+ Everything that affects \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
		- Water, space, sunlight, food, temperatures
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ species
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ niche – wide range of tolerance
* \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ species
	+ \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ niche – narrow range of tolerance

**Case Study: The Giant Panda – A Highly Endangered Specialist**

* 1600 to 3000 Pandas left in the wild
* Pandas need \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
	+ Makes it a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ species
	+ Habitat is currently being \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
* Low \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ rate
	+ Females give birth to \_\_\_\_\_\_\_\_ cubs every \_\_\_\_\_\_\_\_ years

Species Can Play Four Major Roles within Ecosystems

* Native species
	+ Normally live in an ecosystem
* Nonnative species
	+ Not native
* Indicator species
* Keystone species

Indicator Species Serve as Biological Smoke Alarms

* Indicator species
	+ Provide early warning of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ to a community
	+ Can monitor environmental \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Keystone Species Play Critical Roles in Their Ecosystems

* Keystone species
	+ Have a large effect on the types and abundances of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ species
	+ Can play critical roles in helping \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ ecosystems
		- \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_
		- Top \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Case Study: A Keystone Species That Almost Went Extinct**

* The American alligator:
	+ Largest reptile in North America, keystone species in its ecosystems
	+ \_\_\_\_\_\_\_\_\_\_ – Hunted and poached
	+ \_\_\_\_\_\_\_\_\_\_ – added to the endangered species list
	+ \_\_\_\_\_\_\_\_\_\_ – impressive comeback
	+ More than a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ alligators today in Florida

Three Big Ideas

* Populations evolve through mutations in genes
	+ Certain genetic traits enhance individuals ability to produce offspring with these traits
* Human activities are degrading biodiversity
	+ Hastening the extinction of species
	+ Disrupting habitats needed for development of new species
* Each species plays a specific ecological role (its ecological niche) in the ecosystem where it is found

Tying It All Together – Amphibians and Sustainability

* Importance of a species does not always match the public’s perception of it
* Extinction of species may lead to further extinctions
* Biodiversity and evolution
	+ Vital forms of natural capital
* Ecosystems help sustain biodiversity